Remarks

The above Amendments and these Remarks are in reply to the Office action mailed April 28, 2004. Claims 1-15, 27 and 29 are presented herewith for reconsideration.

Objection to Drawings

The drawings are objected to under 37 C.F.R. §1.83(a) for not showing every feature of the invention specified in the claims. Applicant respectfully traverses the rejection as follows.

In the Office action mailed April 28, 2004 (the "Office action"), the Examiner has indicated that "the stationary and moving comb fingers formed by etching down through the substrate must be shown [must be shown] or the feature canceled from the Claims 10-15, 27, and 29." Applicant respectfully submits that this feature is shown in the drawings. Claims 6, 7, 8, 9, 10, 10b and 10c show the stationary and moving comb fingers formed by etching down through the substrate. In particular, as described in the specification starting at page 14, line 15:

> Those of skill in the art would appreciate that microactuator 100 may be fabricated by a number of fabrication methods. An example of one such fabrication method will now be explained in general with reference to Figs. 6-10 and is based upon the method disclosed in U.S. Provisional Patent Application Serial No. 60/222,751 to Brosnihan, T., and Judy, M., filed on August 3, 2000, entitled "Bonded Wafer Optical MEMS Process" converted to a regular patent application on August 3, 2001. This application is hereby incorporated in its entirety by reference. The views shown in Figs. 6-10 are taken with respect to a cross-section through line A-A in Fig. 5 (taken through both the stationary and movable fingers). In one embodiment of the invention, the microactuator 100 is formed in three stacked layers of single crystal silicon wafers: a first handle layer 120, a sacrificial layer 122 and a device layer 124 as shown in Fig. 6. The layers may be separated by an insulator 126 such as silicon dioxide to electrically isolate the respective layers. A conductive contact 128, such as doped polysilicon, may be formed along a portion of the interface, between the handle layer and the sacrificial layer to provide electrical contact with the bottom of the stationary fingers as explained hereinafter. Conductive contact 128 may be isolated from one or more of layers 122, 120 by an additional layer of a dielectric, such as thermally grown or deposited silicon dioxide.

In a first fabrication step, layers 124 and 122 are anisotropically etched down to contact 128 in the shape of the stationary fingers 108 and surrounding trench 109. This etch comprises a first anisotropic silicon etch through silicon layer 124, a first anisotropic oxide etch through the top layer of oxide 126, and a second anisotropic etch through silicon layer 122. Contact 128 may comprise an additional silicon dioxide layer between 128 and 122 (such as a blanket-deposited layer of TEOS-oxide, not shown). In such an embodiment, the second anisotropic silicon etch may use the additional silicon dioxide layer as an etch-stop layer to stop vertical etching after etching through layer 122, since anisotropic silicon etches, and plasma etches in particular, typically may be made selective to silicon in comparison to silicon dioxide. This may be followed by a second anisotropic oxide etch to remove silicon dioxide to expose the surface of 128.

Next, the trench sidewalls are lined with an oxide layer 123. The oxide layer may be formed through, for example, a blanket TEOS deposition step followed by an anisotropic oxide etch to remove deposited oxide from the surface of layer 128. The etched space is then filled with polysilicon as shown in Fig. 7 to form stationary fingers 108 and surrounding trench 109. The polysilicon is preferably doped so as to be slightly conductive, highly conductive or somewhere in between.

Device layer 124 is then patterned in a conventional etch process, forming trenches 124a in layer 124 as shown in Fig. 8, to form the movable fingers 106, a mirror base layer 112 on which the mirror will be formed, and a microspring mechanism 114 (see Fig. 5) that allows flexing of the movable fingers and mirror base pad. Being able to visualize the stationary fingers in this layer allows precise mask alignment of the mask used to etch regions 124a to the defined stationary finger regions. While one embodiment of a microspring 114 is shown, those of skill in the art would appreciate that microspring 114 may have any of various known configurations.

After layer 124 is etched, the remaining portions of layer 124 and 108 are protected with photoresist patterned to expose selected trenches 124a. Next, the portions of layer 126 in these selected regions is removed by a hydrofluoric-acid etching step, thereby exposing regions of sacrificial layer 122. Next, layer 122 beneath movable fingers 106, mirror base layer 112 and microspring mechanism 114 is etched away using a xenon difluoride etch at reduced atmospheric pressure or the like as shown in Fig. 9 to release the movable fingers, base layer and spring mechanism. Spring 114 is anchored to trench 109. A hydrofluoric acid etch may be used to remove oxide 126 from the bottom of layer 124 and the top of layer 120. Finally, a shadow mask 116 of gold is then coated onto the base layer to form the mirror as shown in Fig. 10.

Those of skill in the art would appreciate that microactuator 100 may be formed by a variety of other processing steps. In one such alternative embodiment, the movable fingers 106, base layer 112 and spring mechanism 114 may be formed prior to the formation of the stationary fingers 108.

An alternative embodiment includes both filled high- and low- resistivity trenches to enable a low-resistance contact to the bottom of high-resistance stationary fingers, the low-resistance contact being accessible from the top surface of the device layer. Figure 10c shows a cross-section through line B-B in Fig. 10b, a lightly-doped stationary comb-finger 172 and a heavily doped contact 171 to the bottom of stationary comb finger 172. While a movable, interdigitated comb-finger is not shown in Figs. 10b, 10c, construction of an interdigitated comb-finger follows the steps shown in Figs. 8–10. In Fig. 10c, the starting material is similar to the starting material shown in Fig. 6, except in this embodiment, layer 164, comprising doped polysilicon, is patterned as well as isolated from layers 159 and 160 by two layers of deposited or grown silicon dioxide 162 and 163. Next, the trenches that define stationary comb-finger 172 and contact 171 are simultaneously formed during an anisotropic trench etch, as described above. A two-step deposition process is now performed: first a layer of undoped or lightly-doped polysilicon is deposited of sufficient thickness to form a filled trench 170. This polysilicon is also deposited on the sidewalls of contact 171, as denoted by 165. Next, a heavily-doped layer of polysilicon 166 is deposited to completely fill trench 171. The polysilicon may then be removed from the surface using a silicon etching step, for example a plasma etch. The conductivity is selected by the relative size of the trenches. Metal interconnects may be formed to contact the heavily doped and lightly doped trenches by depositing or growing a dielectric layer 168, such as deposited silicon dioxide, patterning and etching contact holes through this layer, depositing a layer of metal and patterning this metal to form interconnects 167a,b. Implantation and diffusion of an optional dopant at the top of trenches 170 allows ohmic contact between 167b and 170. Thus the stationary comb-finger 172 is electrically connected to at the top by metal interconnect 167b and at the bottom by metal interconnect 167a through trench 171 and polysilicon layer 164.

Thus, it is respectfully submitted that the drawings show the feature of the stationary and moving comb fingers formed by etching down through the substrate, and it is respectfully requested that the rejection on these grounds be withdrawn.

Rejection of Claims 10-15, 27 and 29 Under 35 U.S.C. §112

Claims 10-15, 27 and 29 are rejected under 35 U.S.C. §112, first paragraph, as failing to comply with the written description requirement. Applicant respectfully traverses this rejection as follows.

The Examiner has indicated that application does not contain a "full, clear, concise, and exact written description of the stationary and moving comb fingers formed by etching down through the substrate."

Applicant respectfully submits first that there is no requirement under 35 U.S.C. §112, first paragraph, that the applicant provide a "full, clear, concise, and exact written description." And second, that under the proper standard, the stationary and moving comb fingers formed by etching down through the substrate is adequately described.

In order to comply with the written description requirement of 35 U.S.C. §112, first paragraph, the exact words of the claims need not be found in the specification. The test is whether the specification as a whole conveys that the inventor possessed the invention recited in the claims as of the filing date sought. *In re Gosteli*, 872 F.2d 1008 (Fed. Cir. 1989). "The failure of the specification to specifically mention a limitation that later appears in the claims is not a fatal one when one skilled in the art would recognize upon reading the specification that the new language reflects what the specification shows has been invented." *All Dental Prodx LLC v. Advantage Dental Prods.*, 309 F.3d 774, 779 (Fed. Cir. 2002).

Under this standard, it is respectfully submitted that, upon review of the description of the etching process by which the stationary and moving fingers are formed, it would be clear to the skilled artisan that all of the claim limitations were expressly supported by the specification as filed and that the inventor possessed the invention recited in Claims 10-15, 27 and 29 as of the filing date. In response to the previous Office action, applicant amended Claims 10-15, 27 and 29 to in part read:

> the microactuator formed by the steps of:
>
> (a) forming the stationary comb-finger by etching down through a top layer on the substrate, the top layer being the uppermost layer on the substrate; and
>
> (b) forming the movable comb-finger adjacent to the stationary comb-finger formed in said step (a), the movable comb-finger formed by etching down through the top layer on the substrate, the top layer still being the uppermost layer on the substrate.

The above-cited limitations are clearly supported by the description section set forth above, and shown in Figs. 6-10b filed with the application. The view of Figs. 6-10 are taken through line A-A of Fig. 5 so as to show both the stationary fingers 108 and movable fingers 106 formed by the etching process (page 14, line 23 – page 15, line 2). The specification clearly discloses etching down through the layers 122 and 124 to a contact 128 to define the stationary fingers 108 (page 15, line – page 16, line 10; Figs. 6 and 7). The specification clearly discloses etching the device layer 124 to define the movable fingers 106, the mirror base layer 112, and microspring mechanism 114 (page 16, lines 11-20; Fig. 8). The specification clearly discloses removing portions of layers 126 and 122 to release the movable fingers 106, the mirror base layer 112, and microspring mechanism 114 for movement (page 16 line 21 – page 17, line 8; Fig. 9).

The above portions of the originally filed specification provide express support for Claims 10-15, 27 and 29, and one of average skill in the art would clearly understand that the inventor was in possession of the invention recited in those claims at the time of the invention. Based on these grounds, it is respectfully requested that the rejection on these grounds be withdrawn.

Rejection of Claims 1-4, 7-10 and 27 Under 35 U.S.C. §102(b)

Claims 1-4, 7-10 and 27 are rejected under 35 U.S.C. §102(b) as being anticipated by U.S. Patent No. 5,959,760 to Yamada et al. ("*Yamada*"). Applicant respectfully traverses the rejection as follows.

A. Claims 1-4 and 7-9

Claim 1, and Claims 2-4 and 7-9 dependent thereon, recite a microstructure including in part:

> a first finger including... a first surface...; and
>
> a second finger including a first surface...,
>
> wherein said first surface of said first finger is coplanar with said first surface of said second finger in an unbiased position.

These features are nowhere disclosed, or otherwise taught or suggested in *Yamada*. The respective fingers in *Yamada* lie in different planes, because they are formed in different layers on the substrate during the fabrication process. Thus, based on the limitations in Claim 1, and Claims 2-4 and 7-9 dependent thereon, it is respectfully requested that the rejection of these claims on the stated grounds be withdrawn.

In the Office action at page 9, the Examiner indicated that applicant did not claim moving and stationary fingers in the same plane and therefore could not point to that as a distinction over *Yamada*. The Examiner's grounds for stating this are unclear, as the claims clearly recite that the moving and stationary fingers do have upper surfaces which lie in the same plane. If the Examiner continues in this reasoning as a basis for disregarding applicant's distinction, it is respectfully requested that the Examiner specifically point out the basis for disregarding this claim language.

B. Claims 10 and 27

Claims 10 and 27 recite a microstructure that is formed by the steps of:

(a) forming the stationary comb-finger by etching down through a top layer on the substrate, the top layer being the uppermost layer on the substrate; and

(b) forming the movable comb-finger adjacent to the stationary comb-finger formed in said step (a), the movable comb-finger formed by etching down through the top layer on the substrate, the top layer still being the uppermost layer on the substrate.

These features are nowhere disclosed, or otherwise taught or suggested in *Yamada*. The respective fingers in *Yamada* lie in different planes, because they are formed in different layers on the substrate during the fabrication process.

Moreover, Claims 10 and 27 have been amended to recite that the stationary finger is doped to have a given resistance/support a voltage potential. This feature is not disclosed or suggested in the cited reference.

Based on the above, it is respectfully requested that the rejection of these claims on the stated grounds be withdrawn.

Rejection of Claims 1-4, 7, 8, 10, 11, 27 and 29 Under 35 U.S.C. §102(e)

Claims 1-4, 7, 8, 10, 11, 27 and 29 are rejected under 35 U.S.C. §102(e) as being clearly anticipated by U.S. Publication No. 2002/0005976 to Behin et al. ("*Behin*"). Applicant has amended the claims in a way that is believed to overcome the rejection.

In particular, applicant has amended each of the claims to recite doping of the first or stationary finger. For example:

- "said first finger being doped for supporting a voltage potential between said first and second surfaces" (Claims 1-4, 7 and 8);
- "said stationary comb-finger being doped to provide a resistance of between 0.5 Ohm-cm and 250 Ohm-cm" (Claims 10 and 11);
- "said stationary comb-finger being doped for supporting a voltage potential between said top and bottom portions" (Claims 27 and 29).

This feature is nowhere disclosed, taught or otherwise suggested in the cited reference. In particular, the stationary finger in *Behin* is provided with two distinct conductive layers that are electrically insulated from each other by an insulating layer. As set forth in the reference:

> A preferred embodiment of a multi-layer vertical comb-drive actuator 10 of the present invention is shown in FIG. 1A. The actuator 10 is formed on a substrate 12. A first comb structure 25, may be attached to the substrate 12 contain first comb fingers 14 that may have first conductive layers 16 and second conductive layers 18, which may be electrically isolated from each other by a first insulating layer 20. (Paragraph 21).
>
> The insulating layers 20, 32 of the first and second comb fingers 14, 24 may include layers of insulating materials, such as silicon oxide or an insulating air gap. (Paragraph 22).

Those of skill in the art would appreciate the desirability of having uniform conductivity across the conductive layer 16 and across the conductive layer 18 to provide control and predictability of the electrical properties of, and the electrostatic forces between, the stationary and moving fingers. The insulating layer 20 is relied on solely and entirely to maintain the electrical potential between the conductive layers 16 and 18.

Conversely, the stationary finger of the present invention has no insulating layer, but rather relies on the doping of the layer to establish an electrical potential between the upper and lower surfaces upon application of differing voltages to the upper and lower surfaces. This feature is now expressly recited in the claims and is nowhere disclosed or suggested in *Behin*.

Based on these amendments, it is respectfully requested that this rejection on section 102 grounds be withdrawn.

Rejection of Claims 5, 6, 12 and 13 Under 35 U.S.C. §103(a)

Claims 5, 6, 12 and 13 are rejected under 35 U.S.C. §103(a) as being unpatentable over *Behin*. Claims 5, 6, 12 and 13 rely on either of independent Claims 1 and 10. As discussed above, Claim 1 has been amended to recite doping for supporting a voltage potential, and Claim 10 has been amended to recite doping to provide a claimed degree of resistance. These features are not taught or suggested in the cited reference. As indicated above, those of skill in the art would appreciate that the respective conductive layers 16 and 18 in *Behin* have uniform conductivity, and the electrical insulating layer 20 is relied upon to provide the electrical potential.

Based on the above, it is respectfully requested that the rejection of these claims on section 103 grounds be withdrawn.

Rejection of Claim 8 Under 35 U.S.C. §103(a)

Claim 8 is rejected under 35 U.S.C. §103(a) as being unpatentable over *Behin* and *Yamada*. Claim 8 depends on Claim 1. As discussed above, Claim 1 has been amended to recite features nowhere taught or suggested in *Behin*. *Yamada* adds nothing to the teaching of *Behin* in this regard. Therefore, it is respectfully

submitted that Claim 8 is patentable over *Behin* and *Yamada*, taken alone or in combination with each other, and it is respectfully requested that the rejection of this claim on section 103 grounds be withdrawn.

Rejection of Claims 11 and 12 Under 35 U.S.C. §103(a)

Claims 11 and 12 are rejected under 35 U.S.C. §103(a) as being unpatentable over *Yamada*, in further view of Japanese Publication No. 04-343,318 to Nakagawa et al. ("*Nakagawa*"). Claims 11 and 12 depend on Claim 10. As discussed above, Claim 10 has been amended to recite features nowhere taught or suggested in *Yamada*. Namely, *Yamada* does not teach or suggest coplanar surfaces and does not teach doping to provide the claimed resistance range. *Nakagawa* adds nothing to the teaching of *Yamada* in this regard. Therefore, it is respectfully submitted that Claims 11 and 12 are patentable over *Yamada* and *Nakagawa*, taken alone or in combination with each other, and it is respectfully requested that the rejection of these claims on section 103 grounds be withdrawn.

Rejection of Claim 13 Under 35 U.S.C. §103(a)

Claim 13 is rejected under 35 U.S.C. §103(a) as being unpatentable over *Yamada* and *Nakagawa*. Claim 13 depends on Claim 10. As discussed above, Claim 10 has been amended to recite features nowhere taught or suggested in *Yamada*. Namely, *Yamada* does not teach or suggest coplanar surfaces and does not teach doping to provide the claimed resistance range. *Nakagawa* adds nothing to the teaching of *Yamada* in this regard. Therefore, it is respectfully submitted that Claim 13 is patentable over *Yamada* and *Nakagawa*, taken alone or in combination with each other, and it is respectfully requested that the rejection of this claim on section 103 grounds be withdrawn.

Rejection of Claim 14 Under 35 U.S.C. §103(a)

Claim 14 is rejected under 35 U.S.C. §103(a) as being unpatentable over *Yamada*, in further view of U.S. Patent No. 6,000,280 to Miller et al. ("*Miller*"). Claim 14 depends on Claim 10. As discussed above, Claim 10 has been amended to recite features nowhere taught or suggested in *Yamada*. Namely, *Yamada* does not teach or suggest coplanar surfaces and does not teach doping to provide the claimed resistance range. *Miller* adds nothing to the teaching of *Yamada* in this regard. Therefore, it is respectfully submitted that Claim 14 is patentable over *Yamada* and *Miller*, taken alone or in combination with each other, and it is respectfully requested that the rejection of this claim on section 103 grounds be withdrawn.

Rejection of Claim 15 Under 35 U.S.C. §103(a)

Claim 15 is rejected under 35 U.S.C. §103(a) as being unpatentable over *Yamada*, in further view of *Miller*. Claim 15 depends on Claim 10. As discussed above, Claim 10 has been amended to recite features nowhere taught or suggested in *Yamada*. Namely, *Yamada* does not teach or suggest coplanar surfaces and does not teach doping to provide the claimed resistance range. *Miller* adds nothing to the teaching of *Yamada* in this regard. Therefore, it is respectfully submitted that Claim 15 is patentable over *Yamada* and *Miller*, taken alone or in combination with each other, and it is respectfully requested that the rejection of this claim on section 103 grounds be withdrawn.

Rejection of Claim 28 Under 35 U.S.C. §103(a)

Claim 28 is rejected under 35 U.S.C. §103(a) as being unpatentable over *Yamada*, in further view of U.S. Patent No. 5,862,003 to Saif et al. ("*Saif*"). Claim 28 was cancelled in response to the previous Office action, and it is respectfully requested that the rejection of this claim on section 103 grounds be withdrawn.

Rejection of Claim 29 Under 35 U.S.C. §103(a)

Claim 29 is rejected under 35 U.S.C. §103(a) as being unpatentable over *Yamada*. Claim 29 depends on Claim 27. As discussed above, Claim 27 has been amended to recite features nowhere taught or suggested in *Yamada*. Namely, *Yamada* does not teach or suggest coplanar surfaces and does not teach doping to support a voltage potential. Therefore, it is respectfully submitted that Claim 29 is patentable over *Yamada*, and it is respectfully requested that the rejection of this claim on section 103 grounds be withdrawn.

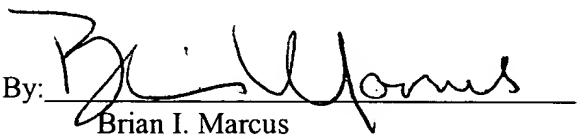
Based on the above amendments and these remarks, reconsideration of Claims 1-15, 27 and 29 is respectfully requested.

The Examiner's prompt attention to this matter is greatly appreciated. Should further questions remain, the Examiner is invited to contact the undersigned attorney by telephone.

The Commissioner is authorized to charge any underpayment or credit any overpayment to Deposit Account No. 501826 for any matter in connection with this response, including any fee for extension of time, which may be required.

Respectfully submitted,

Date: August 17, 2004

By: 

Brian I. Marcus
Reg. No. 34,511

VIERRA MAGEN MARCUS HARMON & DENIRO LLP
685 Market Street, Suite 540
San Francisco, California 94105-4206
Telephone: (415) 369-9660
Facsimile: (415) 369-9665